CALFED BAY-DELTA PROGRAM

Agenda Item 4
Attachment 1

650 Capitol Mall, 5th Floor
Sacramento, CA 95814
Phone: (916) 445-5511
Fax: (916) 445-7297
www.calwater.ca.gov

P. Joseph Grindstaff, Director

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To: Phil Isenberg, Chair
Delta Vision Blue Ribbon Task Force

From: Michael Healey, Lead Scientist
CALFED Bay-Delta Program

Subject: Summary of Science Program Workshop on Organic Carbon in the Delta

On May 16, 2008, the CALFED Science Program hosted a workshop on organic carbon in the Delta. The purpose was to discuss forms and sources of organic carbon in the Delta, its importance to the ecosystem and the problems of organic carbon in drinking water. The workshop included presentations by researchers on various aspects of organic carbon in the Delta and a panel discussion to identify conflicts between ecosystem needs and drinking water needs and how to resolve them. Key conclusions from the workshop were as follows:

1. Organic Carbon (OC) comprises a complex mixture of constituents that differ in form, reactivity, fate and effects in the ecosystem and for drinking water. There is no single, simple characterization of OC in the Delta for either ecosystem or drinking water.

2. In general, the factors that enhance the value of OC for the Delta ecosystem (variable flows, variable salinity, variable water levels, variable water residence time, variable water temperature, adequate OC biomass) degrade the quality of water for drinking water. However, there are approaches to water supply and ecological enhancement that will minimize this fundamental conflict.

3. The Delta generates, on average, about 25% of the Dissolved Organic Carbon (DOC) exported at the pumps. However, the contribution varies seasonally and Delta sources also vary seasonally.

4. Improving ecosystem function in the Delta involves increasing the area of seasonally and tidally flooded wetlands and increasing phytoplankton production through managing flow patterns, nutrient loading and nutrient ratios. Restoration actions of these sorts are likely to increase DOC loading in the Delta, to the detriment of drinking water quality.

5. Hydrodynamically, the Delta can be divided into eight reasonably distinct regions – North Bay, Suisun Marsh, Suisun Bay, Western Delta, Cache Slough Complex, North Delta, Mokelumne System, and South Delta. By careful selection of areas for restoration, any increases in DOC at the export pumps can be kept to a minimum.

6. The most important strategy for reducing organic carbon in drinking water is to separate drinking water intakes from restoration areas. There is not enough operational flexibility left in the system to accommodate both in the same areas.

7. It is essential that ecosystem restoration projects and water quality/supply projects and infrastructure changes be considered together in a holistic, coordinated, comprehensive manner. Many constituents other than OC affect Delta water quality for both ecosystem and drinking water. Improvements are needed from both the ecosystem and drinking water perspectives.

8. Hydrodynamic modeling, large-scale experiments and monitoring are all needed to allow fuller understanding of the effects that changes in restoration and changes in conveyance will have on both the ecosystem and on drinking water quality. This should be done under the umbrella of adaptive management.

The workshop agenda and individual presentations can be found on the Science Program web site (www.science.calwater.ca.gov/). Further background material relevant to organic carbon in the Delta may also be found in the recent Science Action publication from the Science Program, "Tracking organic matter in Delta drinking water" (www.science.calwater.ca.gov/pdf/publications/sia/SIA_DOC_041608.pdf). This memo summarizes my interpretation of the workshop discussion supporting the conclusions listed above. It is framed around a set of key questions that were used to focus discussion at the workshop.

1. Defining Conflicts and Congruencies:

Organic Carbon (OC) comprises a complex mixture of constituents that differ in form, reactivity, fate and effects in the ecosystem and for drinking water. A typical OC breakdown in Delta waters is 33% Particulate Organic Carbon (POC) and 67% Dissolved Organic Carbon (DOC). POC includes: old, highly degraded, terrestrial carbon derived from soils; new detrital carbon (fragments of aquatic and terrestrial plants); and planktonic carbon, produced by planktonic algal production near or within the Delta. DOC is comprised of thousands of different compounds. POC, particularly algal production, fuels the Delta aquatic foodweb supporting native species. Dissolved Organic Carbon (DOC) also fuels the foodweb, but is much less efficient than POC in supporting desired species like fish. DOC reduces the quality of Delta water for drinking water as it forms cancer causing disinfection byproducts when treated. Some types of algae (POC) are also bad for drinking water as they cause taste and odor problems. In general, the factors that enhance the value of OC for the Delta ecosystem (variable flows, variable salinity, variable water levels, variable water residence time, variable water temperature, adequate OC biomass) degrade the quality of water for drinking water. However, there are approaches to water supply and ecological enhancement that will minimize this fundamental conflict.

There are many sources of organic carbon in the Delta. The majority of organic carbon in the Delta is transported into the Delta from the Sacramento and San Joaquin rivers. Approximately 25 percent (on average) of the DOC exported at Banks and Tracy is produced within the Delta. However, the sources of POC and DOC, their composition, and their significance for the ecosystem and for drinking water change seasonally. For example, island drains are an important source of DOC in the winter, whereas wetlands are an important source in spring and summer. The phytoplankton component of POC is particularly important to the food web supporting fish in the Delta. However, the quality of this food source appears to have declined over time as the phytoplankton community has shifted from diatoms (a high quality food source) to blue green algae (a low quality food source that can sometimes also be toxic). There is no single, simple characterization of OC in the Delta for either ecosystem or drinking water.

a. What effects will the proposed actions for restoring the Delta have on organic carbon for the ecosystem and organic carbon in drinking water?

A great deal of Delta restoration focuses on reconnecting river channels and sloughs with their floodplains, thereby increasing the amount of seasonally and tidally flooded wetlands. Wetlands are an important source of OC in spring and summer and wetland DOC has a high propensity to form Haloacetic Acids (HAAs) and Trihalomethanes (THMs). However, not all wetlands are the same. Different wetlands produce different amounts of OC, and may export OC differently depending on the configuration of the wetland, how it is connected to adjacent channels, and channel geometry.

The Delta has relatively low phytoplankton production, although it is within the normal range for coastal estuaries. Because Delta water is turbid, phytoplankton production is mainly light limited. However, recently the Delta water has been getting clearer so that phytoplankton production may now sometimes be nutrient limited, particularly in shallow or intermittently flooded habitats. An objective of restoration is to boost phytoplankton production, especially production of diatoms. Phytoplankton production can be boosted in a number of ways: by managing the flow regime; by managing nutrient concentrations and ratios; by increasing acreage of intermittently flooded floodplain and marsh; and by managing habitat connectivity.

In managing restored wetlands and floodplains for phytoplankton production and fish food production, several factors need to be taken into account:

a. Floodplains need to be inundated at the right time of year and for the right length of time to benefit the native species that spawn and rear there and also for the export of food to connecting channels.
b. Location, size and connectivity are important in terms of materials and organisms moving in and out of the floodplain or marsh. Early season inundation is better for native species.
c. Tidal marshes are inundated more frequently than seasonal floodplains and marshes and a lot more OC cycling occurs in them. Some OC is exported from tidal marshes, but most of the action occurs within the marsh.

In terms of the conflict between the desire for high OC to support ecosystem processes and low OC to provide high quality drinking water, location of restoration matters a lot. Based on flow patterns, the Delta can be divided into eight reasonably distinct hydrodynamic regions – North Bay, Suisun Marsh, Suisun Bay, Western Delta, Cache Slough Complex, North Delta, Mokelumne System, and South Delta. The Cache Slough Complex, Suisun Marsh and Liberty Island are good candidate areas for restoration due to their hydrodynamics, lack of connectivity to major drinking water sources, and high current primary productivity.

Transport processes are also important. Transport of OC from Suisun to South Delta is unlikely, so restoration in Suisun Marsh will not impact OC levels in water exported from South Delta. Impacts at the North Bay Aqueduct (NBA) in Barker Slough are localized. It isn't heavily impacted by hydrodynamics in the system, but it is affected by local OC production. Contra Costa's drinking water intakes are very impacted by transport and hydrodynamics because there is a lot of mixing in Central Delta.

b. *What effects will the proposed changes in conveyance have on organic carbon for the ecosystem and organic carbon in drinking water?*

An isolated facility carrying Sacramento River water to the export pumps will reduce OC in export water. But since the Delta would then receive a relatively higher amount of water from the San Joaquin River, Delta OC would increase because the San Joaquin River delivers a higher concentration of OC than the

Sacramento River. Therefore, while an isolated facility would improve the quality of water exported by the state and federal projects, drinking water withdrawn from within the Delta would be of lower quality.

Changing the balance of Sacramento and San Joaquin River flows into the Delta and the amounts of water flowing into the Delta will have consequences for a broad range of water quality parameters in the Delta, not just OC. Any analysis of the effects of changing conveyance needs to take a broad holistic view of impacts on the ecosystem.

2. *Strategies for Resolving Conflicts:*

A number of potential strategies for minimizing the conflict between OC for the ecosystem and in drinking water have already been hinted at. Separation of water for ecosystem from water for drinking is part of the solution. However, location and design of restoration projects is also important. It is doubtful that any strategy will completely eliminate the conflict under a dual conveyance approach.

a. *What are the possible strategies to manage organic carbon at Delta drinking water intakes and how well might they work?*

The most important strategy for reducing organic carbon in drinking water is to separate drinking water intakes from restoration areas. There is not enough operational flexibility left in the system to accommodate both in the same areas. This means that the North Bay Aqueduct intake and probably also the Contra Costa Intakes need to be relocated. Intakes should also be located where water flows past the intake rather than in dead-end sloughs.

As noted earlier, based on flow patterns, the Delta can be divided into eight reasonably distinct hydrographic regions – North Bay, Suisun Marsh, Suisun Bay, Western Delta, Cache Slough Complex, North Delta, Mokelumne System, and South Delta. How each region works has implications for either restoration or conveyance. Taking advantage of the unique hydrodynamic aspects of each region, and their relative isolation will allow greater separation between ecosystem and drinking water.

It is essential that ecosystem restoration projects and water quality/supply projects and infrastructure changes be considered together in a holistic, coordinated, comprehensive manner. Improvements are needed from both the ecosystem and drinking water perspectives.

Hydrodynamic modeling, large-scale experiments and monitoring are all needed to allow fuller understanding of the effects that changes in restoration and changes in conveyance will have on both the ecosystem and on drinking water quality. This should be done under the umbrella of adaptive management.

We need to do better source control. Currently there are no surface water quality objectives for organic carbon (although drinking water quality is regulated using TOC). This is a constituent that could be regulated in wastewater and in agricultural and urban storm water discharges. We could also consider requiring advanced wastewater treatment, and having agricultural dischargers monitor and devise best management practices for OC under the irrigated lands program.

b. *The system is also being managed for salinity: what are the limitations, challenges, and tradeoffs among strategies to manage for salinity and strategies to avoid organic carbon in drinking water/strategies to enhance ecosystem function?*

The workshop did not address this question directly. However, as part of the need for a holistic approach to water quality analysis, panelists recognized the need for a more comprehensive assessment of the broad range of aquatic contaminants and their sources. Various strategies were discussed including:

1. Controlling contaminants in agricultural and urban runoff through advanced wastewater treatment and new Best Management Practices;

2. Reducing impervious surfaces to encourage infiltration and reducing the amount of runoff through more efficient water use;

3. Recycling and reusing wastewater;

4. Constructing treatment wetlands to capture contaminants in agriculture and urban runoff; and

5. Reducing ammonia discharge from treatment plants as ammonia inhibits growth of desirable algae and encourages growth of undesirable algae and plants.